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NR. 1. C. G. JOH. PETERSEN: ON THE LARVAL AND POSTLARVAL STAGES OF SOME *PLEURONECTIDÆ* (*ZEUGOPTERUS, ARNOGLOSSUS, SOLEA*). WITH 2 PLATES

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
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ON THE LARVAL AND POSTLARVAL STAGES OF SOME *PLEURONECTIDÆ (ZEUGOPTERUS, ARNOGLOSSUS, SOLEA)*

BY

C. G. JOH. PETERSEN

(WITH 2 PLATES)

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Introduction.

The present work appears partly as a supplement to two earlier papers of mine (see List of Literature, 16a and b) dealing with the Pleuronectid larval stages, especially of the *Zeugopterus* genus, collected on the cruises of the "Thor". Along with a third later work (Meddelelser fra Komm. for Havundersøgelser, Bind I, No. I, 1904): "On the larval and post larval stages of the long-rough dab and the genus Pleuronectes", it forms the conclusion to my investigations on the less known Pleuronectid larvæ which occur in our Danish collections.

The Pleuronectids of the genera *Solea* and *Arnoglossus* occurring in the deep Atlantic waters south of the British Isles do not seem well known or described even as adults, and this is the reason most probably why the identification of the young has caused me such great difficulties. I have, nevertheless, with due reservation and caution, given what I believe could be given to throw light on the relationships of these forms; future investigations must correct the errors and in any case supplement what is lacking, but I believe that good advance has been made in the matter by the present investigations.

Cand. mag. A. Strubberg has offered me very great help with this work, both in the arrangement of the material and with the determination and study of the larvæ; without his assistance it would not have been possible for me to find time to complete this work.

København 1908.

Pelagic larvæ of the the genus Zeugopterus.

In a "Preliminary Note", pp. 8—9 of Med. fra Komm. for Havunds. Serie: Fiskeri, Bd. II, No. 1, 1906 (16b), I have briefly mentioned the discovery of 2 kinds of *Zeugopterus* larvæ, which must be referred to 2 more southerly species, *Boscii* and *unimaculatus*. I had already described in detail, in the Report of the Biological Station, XII, 1904, pp. 24—30 (16a), the larvæ of the three other, true northern species, *punctatus*, *norvegicus* and *megastoma*, and a description of the larvæ of the two first-named species is therefore due from me. Since, however, our collections in 1905 and 1906 have brought in much better series, also of the development of the 3 last, I have likewise given figures of the larvæ of these. *Zeugopterus norvegicus* especially must be admitted to be badly represented in my earlier figures (16a, Pl. 1, figs. 6—8). As I have stated in my earlier paper, that Ehrenbaum had been unable to separate the different *Zeugopterus* species from one another in "Nordisches Plankton", I owe it to him here to say that he himself has expressed in his work his doubts as to the correctness of his determinations in several cases, which I have not pointed out sufficiently in my "Preliminary Note"; but which I expressly mention here in his defence; I hope now that my figures of more complete series will in future help over all such

difficulties in the determination of these species. For *Z. punctatus, norvegicus* and *megastoma* we have now such complete series of larvæ that there can be no doubt of the correct determination of these larval stages; for the two other species, *Z. unimaculatus* and *Boscii*, the position is however different, although in the case of the last the series is fairly complete and becomes still more so with the aid of the larvæ figured by HOLT (in 11 a, Pl. XV, fig. 116). There is as yet no direct evidence that the fifth larval form of *Zeugopterus* present in our collections can really be referred to *Z. unimaculatus*, but there is nothing in its distribution or structure to indicate the contrary (see below). We have still only the 11 specimens found at Dungeness (English Channel).

Regarding the description of the *Z. megastoma* larvæ I have nothing essentially new to add to what I have written in the Report from the Biological Station, XII; various details are however given in the explanation to the figures. The whole series figured here (Pl. I, figs. 7—12) will facilitate future determinations of these larvæ, as also remove all doubt as to the correctness of the identification of the species.

Regarding the distribution of the larvæ, both of this species and of the other Pleunonectids, I shall probably return to this subject in a later work.

On the *Z. norvegicus* larvæ I have nothing new to add and need only refer to the XIIth Report from the Biological Station. The description of the figures on Pl. I gives sufficient information. The metamorphosed stage has been figured earlier in 16 a, Pl. I, fig. 8. This species lacks the true "otocystic" spines.

There is nothing new to add either regarding the *Z. punctatus* larvæ, except that these as well as the larvæ of the preceding species have been found to be armed with spines, partly on the preoperculum and partly on other regions of the head, to a greater degree than hitherto known. For the rest, we may refer here also to the description of the figures and XIIth Report from the Biological Station.

In regard to the figs. 20 and 21 of the *Z. unimaculatus* larvæ, it may be noted here, that the strongly developed "otocystic spines" very distinctly show their relation to the *Zeugopterus* genus. The characteristic pigmentation of small dots, scattered over almost the whole of the larva, resembles greatly the pigmentation in young *Z. norvegicus* larvæ. Unfortunately the state of preservation of all the specimens found is not good.

Fig. 20 represents the smallest of the larvæ; it was taken like all the other 10 of the same species in the English Channel (50° 43′ N. Lat., 0° 43′ E. Long.), young-fish trawl, 65 meters wire out, depth 41 meters, on June 30th 1905. The total length is 6·7 mm., of which 3·2 mm. represents the distance from tip of the snout to the anus; the length of the lower jaw is 1 mm. As already mentioned in the "Preliminary Note" (loc. cit.), the form of the larva, especially the characteristic shape of the head, has a great resemblance to the larvæ of *Z. punctatus* (see figs. 1—2, Pl. I). It is perfectly symmetrical; the notochord quite straight; there are faint signs of the developing dorsal and anal interspinous bones, but not of the fin rays. On the other hand, distinct indications of rays can be seen in the ventral part of the embryonic caudal fin. The pectoral fins are still quite larval and no signs are present of the ventral fins. The pigment is distributed over the whole body and as above mentioned its character recalls that in young *Z. norvegicus* larvæ. The small, dendritic chromatophores are very densely and diffusely distributed over the body and the tail, less dense on the sides of the head. Only the margin of the fin at the end of the tail is quite without pigment. As mentioned above, there are two slender "otocystic spines" on each side, as also some small spines on the posterior border of the preoperculum. Other spiny equipment cannot be seen.

The oldest stage of development amongst the 11 larvæ is shown in fig. 21. It is still symmetrical and the fin rays are now rapidly developing. The total length is 8 mm. The anus lies 4 mm. behind the snout, the length of the lower jaw is 1·5 mm.; 77 developing dorsal, 56 anal and 11 caudal rays can be counted, but more have certainly still to be formed. The pectorals are larval; the ventral fins cannot

be seen with certainty. The number of vertebræ can be put down at 10 + ca. 26 (after staining by methyl-green).

The pigmentation and the spiny equipment are essentially unchanged.

My reason for referring these larvæ to *Z. unimaculatus* is, in the first place, that it is the only *Zeugopterus* occurring north of the Bay of Biscay, the larvæ of which is still unknown. Hitherto, however, the larvæ of *Z. Boscii* have not been known with certainty, but as will appear from my remarks on these, there can be no doubt that they have now been rightly identified. The occurrence of the 11 larvæ in the Channel towards the end of June agrees well with what HOLT (11 b, p. 45) states regarding the observation of 3 sexually ripe specimens of *Z. unimaculatus* in the central part of the Channel (Teignmouth Bay) on June 1st 1897. That these larvæ are not known from other places round the coasts of the British Isles agrees well on the one hand, with the fact, that this species is rare so close to its northern boundary (see DAY, 5), on the other that our investigations close to the land have been relatively few and for the most part restricted to periods, which obviously do not correspond to the months when the pelagic young of this species might be expected to occur.

Lastly, the correctness of our determination is made more probable by the description HOLT (l. c.) has given of the tiny larvæ hatched from artificially fertilised eggs. He was not able, certainly, to keep the larvæ living very long, the largest reached only 2·38 mm. and had still when it died a fairly large yolk-sac. Yet they already shoved a characteristic, diffuse distribution of the large and yellow chromatophores; the dark dots were specially dense on the sides of the tail. He himself remarks on the resemblance between these small *Z. unimaculatus* larvæ and the tiny *Z. norvegicus* larvæ in regard to the diffuse pigmentation. As will be seen, there is an obvious agreement between the small larvæ of HOLT and the distribution of pigment in our larvæ, even if there is unquestionably a gap in the degree of development from the largest of HOLT's larvæ (2·38 mm.) to our smallest (6·7 mm.).

For the sake of completeness it may finally be mentioned, that there is a certain agreement in the number of rays and vertebræ between the adult *Z. unimaculatus* and the largest of our larvæ, although the latter has not yet had its full number laid down. The following table summarises the conditions.

Number of rays and vertebræ in *Zeugopterus unimaculatus*.

	D	A	Vert.
MOREAU (Poissons de France)	70—80	61—68	.....
1 of our adult specimens from the Bay of Naples	82	66	9 + 26
The largest of our larvæ (fig. 21)	77	> 56	10 + ca. 26

Of *Zeugopterus Boscii* we have a well-represented series of larvæ, the smallest of which is 5 mm. long and already considerably developed, while the largest is 17 mm. but as yet not quite metamorphosed. As already mentioned in my "preliminary Note" (l. c.) the "otocystic spines" are wanting in this larval form. It is however easily identified as a true *Zeugopterus* by the perforated septum of the gill-cavity. Counting the fin-rays and vertebræ in the largest of our larvæ, the numbers agree very well with what is found in adult specimens of this species. In the collections of the "Thor" from 1905, 1906 and 1908 these larvæ appear but rarely, altogether there have only been taken 68 specimens, spread over the part of the Atlantic Ocean which lies W. and S. W. of Scotland and Ireland. They are generally found at great depths (1000 meters); only in a few cases, e. g. on the Rockall Bank, have they been met with at depths less than 200 meters. The period of occurrence seems to be limited to the months of May and June, at least the investigations in August and September gave only a negative result.

So far as the distribution of the adult *Zeugopterus Boscii* is known, they are to be found within the territory explored by the "Thor" along the W. and S. W. coasts of Ireland and in the Bay of Biscay: a distribution which on the whole agrees with that of the larvæ just mentioned. The species is also

known on the coasts of Portugal, in the Mediterranean and the southern part of the Atlantic (Azores). It is always found at considerable depths (130—315 fms. on the S. W. coast of Ireland; GÜNTHER in Ann. and Mag. of Natural History, 1889, p. 418).

The stages of development figured form together a series, the individual links in which are very closely connected, partly by characteristic pigmentation and partly by a characteristic spiny equipment. The smallest specimen reproduced, fig. 22, measures 6 mm., of which 3 mm. fall to the body and the head and 4 mm. to the tail; the length of the lower jaw is 1·5 mm. The measurements are here, as all through this paper, taken on the preserved specimens (formaline 2 %). The larva is still perfectly symmetrical; the notochord quite straight. Indications of interspinous bones appear in the anterior part of the dorsal and anal fins. Embryonic rays are present in the ventral part of the caudal fin. The pectorals are quite larval, very large; the ventrals begin to appear as quite low warts at the lowermost end of the clavicular arch.

The pigmentation is specially characteristic, recalling greatly the distribution of pigment in young, pelagic stages of *Pleuronectes microcephalus*, as has already been pointed out in my above-cited "Preliminary Note" (l. c.). Fig. 22 shows clearly the whole pigmentation.

The head, with its extremely powerful, prominent jaws, has a spiny equipment which as mentioned previously differs somewhat from what is found in the larvæ of several other *Zeugopterus* species; thus, the "otocystic spines" are quite wanting, but a little behind the otocystic region we find at the upper end of the pectoral girdle a small spine, both on the right and on the left side of the head; there are no other traces of spines on this part of the head. On the other hand, the preoperculum is well-provided with small spines, partly in a row on the anterior border, partly as a group of 3—4 slightly larger spines high up on the posterior border.

The next stage figured (fig. 23) shows various advances in development. It is in all 9.7 mm. long, the length of the lower jaw is 2 mm., the distance from the tip of the snout to the anus 4 mm., the tail 5·7 mm. The notochord is bent upward and the asymmetrical form has begun to show. A considerable number of rays are already laid down in the unpaired fins, as also in the ventrals, but the pectorals are still, as in the following stages, larval without signs of rays. We can count with certainty 79 dorsal interspinous bones and 67 anal. The developing rays seem to be weakest in the anterior and posterior parts of these two fins. In the caudal fin ca. 16 rays are formed and in the ventrals ca. 4.

The number of vertebræ cannot be given with certainty for the caudal portion. Treatment with xylol shows that there are 10 abdominal $+ > 29$ caudal vertebræ. The pigment is essentially distributed as in the foregoing specimen, but a little fainter. It may be remarked here that the caudal fin is almost pigmentless on all the stages figured. The spiny equipment on the head is a little more developed than in fig. 22. The row of spines along the anterior border of the preoperculum extends a little higher up; it now consists of ca. 8 small, wedge-shaped spines. The group of spines on the posterior border has also spread upwards and likewise downwards; the number of spines is here ca. 6. A few are present on the surface of the bone. At the uppermost end of the pectoral girdle we now notice 3 closely placed spines, as large as the small opercular spines. As was the case in the younger specimen there is no difference here in the spiny equipment on the left and right sides.

Fig. 24 shows a still more advanced stage in development. The migrating eye has come somewhat higher up on the dorsal ridge of the head; it can now be seen distinctly from the left side. The total length is 10·4 mm.; the distance from the tip of the snout to the anus 4·4 mm., the length of the lower jaw 2 mm. The embryonic fin has now almost entirely disappeared, except that traces of it may still be noticed far back on the dorsal and anal fins. The number of rays in these two fins is respectively 80 and 67; it is more difficult to give exact numbers for the caudal fin, but ca. 16 rays can be

distinguished; the ventral fins each show ca. 4 developing rays. The number of vertebræ is, as before, 10 abdominal, at least 29 caudal, but the limits between the last few vertebræ are uncertain.

In comparison with fig. 23 the spiny equipment shows a greater development of the row on the anterior border of the preoperculum, where new spines appear both above and below the original. The spines on the upper end of the pectoral girdle appear as before, as also those on the surface of the preoperculum. The pigment is as before in regard to distribution and number of groups, but the separate spots are more distinct; they spread especially on the fin inwards towards the proximal part. Teeth indistinct.

The oldest stage in our collections is shown in fig. 25. Its length is 17 mm., the distance from the tip of the snout to the anus amounts to 4·8 mm., the lower jaw measures 2·6 mm. along the ventral margin; the migration of the eye is not quite completed, the front part of the dorsal fin is seen to be advancing along the dorsal ridge of the head over the migrating eye.

The number of rays is as follows: D. 83, A. 68, C, 1 + 17 + 1, V. 6. The number of vertebræ can here at last be determined as 10 abdominal and 31 caudal; the pigment has somewhat changed its character, as several more, smaller groups of chromatophores appear on the left side of the body. The spots on the dorsal and anal fins are still very prominent; here also the caudal fin is pigmentless.

The spiny equipment has become much reduced; only a few spines of the posterior row on the preoperculum remain and only some few and small remains of spines at the uppermost end of the pectoral arch. In these specimens teeth are present on both sides of the jaw, but they seem to be weaker and fewer on the intermaxillary of the eyed side than on the remaining parts of the jaw.

That in these short and broad larvæ we have larval forms of a *Zeugopterus* species, is proved *inter alia*, as said before, by the perforated septum of the gill-cavity. There can thus, as already stated in my "Preliminary Note" (l. c.), only be a question of referring these larvæ to one of two *Zeugopterus* species, namely, either *Z. Boscii* or *Z. unimaculatus*. Amongst other things, the geographical distribution of the larvæ in question excludes the idea that we can have to do with any of the other three, more northerly species.

Zeugopterus Boscii, the independence of which species was for a time doubtful, is characterised according to Cligny's investigations in "Annales de la station aquicole de Boulogne-sur-mer, Nouv. Sér. vol. I — 1905, p. 88—92", *inter alia*, by the following number of rays:

	D	A	Vert.
11 specimens from the Bay of Biscay...	82—89	65—70	.....
4 of our pelagic larvæ.....	84—88	68—71	10 + 31

If we compare Cligny's data with the number of rays in our 4 pelagic larvæ near the termination of the metamorphosis and quite agreeing with the larva represented in fig. 25, we find an indisputable agrement. The number of vertebræ, counted in an adult specimen from Ireland by Strubberg, amounted to 10 + 31, thus corresponding to the numbers in the older larvæ. Comparing these numbers with what is given for *Zeugopterus unimaculatus* (see above), as follows:

	D	A	Vert.
According to Moreau	70—80	61—68	.....
1 of our specimens from Naples....	82	66	9 + 26

we see, especially from the number of vertebræ, that we have to do with a different species.

The appearance of fig. 25 also shows great resemblance to that of the adult *Z. Boscii*: On the one hand, the head already shows the slightly pointed profile so characteristic of the last-named species; on the other hand, the body narrows evenly backwards towards the slender caudal peduncle. In the adult

Z. unimaculatus the profile of the head is obtuse and the posterior part of the body is truncated, whilst the caudal peduncle is short and broad — characters which are not at all like those of *Z. Boscii.*

Lastly, as already mentioned, we are in possession of 11 specimens of a spined *Zeugopterus* larva, which in all probability may be referred to *Z. unimaculus.* These larvæ come from the English Channel, where *Z. unimaculatus* occurs but where *Z. Boscii* does not seem to live. Nor have we from there a single specimen of the supposed *Z. Boscii* larvæ.

Altogether, the agreement in distribution, in number of rays and vertebræ and to a certain extent in form between the larvæ dealt with and the adult *Z. Boscii* speaks definitely in favour of the correctness of the determination.

Pelagic larvæ of the genus Arnoglossus.

Of young fish which must be referred to the genus Arnoglossus, with the, for this genus, characteristic "Tentacle" on the head, we find in our collection 3 species; 2 of them of a more southerly distribution, the northern boundary of which lies on the west side of the British Isles and in the Channel and one going through the North Sea to Denmark and Norway.

There is no doubt that this last group of larvæ belongs therefore to *A. laterna*, and we have series from quite tiny pelagic right up to the old metamorphosed specimens.

To EHRENBAUM's descriptions and drawings (6a and b) there is nothing new to add except that the elongated dorsal fin ray (tentacle) in all the larger pelagic Arnoglossus larvæ from the North Sea is the 2nd ray.

Fig. 30 shows an *Arnoglossus laterna* 18·2 mm. long almost perfectly symmetrical, taken west of Horn's Reef in September 1904. The figure is a combination of 2 equal-sized specimens, 1 from west of Horns Reef, 1 from Vyl lightship. Fig. 31 shows the foremost part of the same specimen seen from the blind side. We find that in front of the elongated ray on that side there is a small anterior, imperfect ray just as drawn by RAFFAELE (17) for the *A. Grohmanni* larvæ. The skeleton is first formed later in this small foremost ray, its interspinous bone on the contrary is present at an early stage[1]. After the transformation of the eye, the elongated ray is reduced and differs in no way from the succeeding ones.

The metamorphosis is completed at sizes, according to EHRENBAUM (16a), of about 16 mm. (measured on preserved material), in any case at a much shorter length than for the two other species of Arnoglossus. As a maximum for symmetrical *A. laterna* larvæ he gives 15·6 mm. (preserved material). We have pelagic symmetrical larvæ of 24 mm. in length, that probably must be referred to *A. Gromanni*, similar ones of *A. lophotes* of about 36 mm., while metamorphosed specimens of these species, judging from our material, measure about 30—31 mm. in length. I have not been able to find any descriptions of *A. Gromanni* larvæ[2], but HOLT states[3] that they can attain a size which far exceeds that of *Pl. cynoglossus* larvæ. Excepting in size, I have not been able to find any difference in appearance between these large pelagic larvæ and the smaller *A. laterna* larvæ, as described by EHRENBAUM (6a).

The young of *A. Grohmanni*, on the other hand, are known in stages after the completion of the metamorphosis by the strongly developed and pigmented 2nd dorsal ray. Fig. 34 shows a transformed *A. Grohmanni* larva 28·5 mm. in length seen from the blind side, taken close to the Spanish Coast in the Bay of Biscay, beginning of May 1906. The second ray is covered with a thick strong pigmented skin. In some few specimens this is still more developed than shown in the figure. I have found it as a rule

[1] cf. Raffaele (l c. p. 52).

[2] cf. Graeffe, 9, the larva he mentions probably belongs to *A. Grohmanni.*

[3] cf. 12a.

impossible to distinguish between the larvæ of these two species in the earlier pelagic stages, although both must be represented in our collections. Only at 2 stations, viz: at Stations 40 and 194 near land in the south-eastern part of the Bay of Biscay and in the English Channel, have we found small Arnoglossus larvæ which were distinguished from small *A. laterna* from the North Sea as EHRENBAUM describes and figures them (loc. cit.) by having different and stronger pigment and longer "tentacle". It is in the meantime undecided which species of Arnoglussus they belong to and it is therefore only provisionally that they are referred here to *A. Grohmanni.*

Two of these strongly pigmented larvæ are shown in figs. 32 and 33. The one (fig. 32) which has a length of about 5 mm. was taken together with 11 others (all 5—7 mm. long) at St. 194 south of Brittany: 47° 42′ N., 5° 30′ W., 12—IX—1906. These 12 are all characterised by well developed pigment and long tentacle, unless the latter has been torn off, as the preservation is not of the best. The specimen figured is perfectly symmetrical, the tip of the notochord still quite straight. The tentacle is about 3 mm. long with the skeleton already formed in it and seems to have been covered with a rather thick skin in which can still be seen a few chromatophores. The large interspinous bone to which it is attached is also present. At its distal end is a group of 5 small, slender spines. Apart from the elongated ray all trace of developing rays is almost lacking, slight signs being seen only in the hypural rays; the swim bladder is present; the gut has the same characteristic course as shown on fig. 12, Plate 3 of RAFFAELE (17), of a larva he calls *Arnoglossus* spec. a little over 5 mm. in length, and which EHRENBAUM (6a; Plate V, fig. 26) again finds in *A. laterna* larvæ 4—7 mm. long. On the whole the resemblance in appearance, especially with RAFFAELE's fig. 12, Plate 3, is great; differences are only seen in the pigment. In our larvæ there are namely two postanal pigment bars while the Arnoglossus larvæ mentioned above, of ca. 5 mm. in length described by RAFFAELE, seems according to his text and drawing not to have had more than one. The foremost bar is by far the strongest; it is placed rather behind the middle of the tail and according to its position corresponds exactly to the conspicuous, postanal pigment bar the *A. laterna* larvæ are provided with. It consists of a dorsal and a ventral part divided by a less pigmented region, each part consisting of about 6—9 large stellate chromatophores. Neither the dorsal nor the ventral part reach to the margin of the fin. The posterior pigment bar is placed quite near the end of the notochord and is much less developed and not so conspicuous as the foremost one. It varies greatly in all the 12 specimens. Where best developed it consists of a group (about 6—8) of pigment cells placed on the ventral edge of the outermost part of the notochord and of a very few dorsally to these. Corresponding to the ventral chromatophores a small number of pigment cells are found spread over the ventral part of the embryonic border of the end of the tail. In other specimens the dorsal portion of the pigment is reduced and indeed may be missing entirely, while the ventral may be limited to only a very few chromatophores. Probably it is a specimen of this kind RAFFAELE figured. Besides these two postanal bars we find up to about 10 scattered, quite faint chromatophores in some few of the larvæ, along the ventral edge of the body between the bars. Otherwise the pigment is distributed just as in the larvæ of *A. laterna* of the same size; thus, we also find here a group of pigment cells on the last fold of the intestine and a group dorsally in the abdominal cavity. There is no pigment on the notochord. Nothing can be said regarding the pigment on the edge of the embryonic fin owing to the poor state of preservation. The most essential difference in regard to the pigment, comparing naturally specimens of about 5—6 mm. in length and in about the same stage of development, is found, firstly, in that the hindmost postanal bar is not developed as such in the young of *A. laterna* and secondly, that the pigment on the ventral edge of the body behind the anus is much stronger and denser extending right out towards the tip of the tail in the *A. laterna.* The two species obviously vary however so much that it is far from always that the pigment shows the typical condition. Otherwise the appearance is very similar so far as our small material permits us

to judge, only, as already mentioned, the elongated ray (tentacle) seems to be very much longer in the strongly pigmented larvæ before mentioned than in the corresponding *A. laterna* (from the North Sea).

The reason why we refer these more strongly pigmented larvæ with long "tentacle" to *A. Grohmanni*, even with some reservation, is that they resemble the tiny larvæ HOLT (11d) describes as belonging to that species. He has had the eggs and small larvæ both from the Mediterranean and the Channel. The largest of his larvæ (2·32 mm.) has already the postanal pigment divided into two transverse bars like our larva of 5 mm. He also emphasizes this as in his opinion giving a character for the separation from the larva of the same size of *A. laterna*.

Naturally there is still the possibility that our larvæ represent quite another species although this is not very probable.

The 2nd of the figured, strongly pigmented Arnoglossus larvæ (fig. 33), which is about 8 mm. in length, was taken along with three similar (8—11·7 mm.) and 5 larger (about 20—30 mm.) pelagic *Arnoglossus Grohmanni* larvæ at St. 40 in the innermost part of the Bay of Biscay in May 1906.

Its notochord is very feebly bent upwards. There are signs of interspinous bones for the developing dorsal and anal fin rays, and faint traces of rays ventrally to the notochord and in the dorsal and ventral embryonic fin. The body has grown in height in comparison with fig. 32 and the abdominal cavity is more prominent. The elongated ray is still of a relatively good length but its growth in length does not keep up with that of the body. The "tentacle" is here seen more distinctly than in the quite small larvæ, (cf. fig. 32) covered with rather thick skin in which can still be seen a few chromatophores.

The pigment shows as before inter alia a well-developed, foremost postanal spot, consisting of a dorsal and a ventral part separated by a broad pigmentless region which extends a little on to the sides of the body. The posterior postanal pigment spot is not very strong but is found in all 4 small specimens in the form of chromatophores on the base of the developing caudal rays.

Lastly, the usual Arnoglossus pigment is in process of development in the form of a series of densely placed chromatophores along the base of the dorsal and anal interspinous bones and on the ventral edge of the preanal region of the body, a group of pigment cells on the swim bladder etc.

The margin of the embryonic fin is strongly pigmented. There is almost no notochordal pigment as yet, indicated only by a few specks. The number of interspinous bones can be counted as: ca. 95 in in D, ca. 68 in A. The number of vertebræ is 10—30, which number agrees with both *A. Grohmanni* and *A. laterna*. In other respects the correctness of the determination is even more uncertain than for the above mentioned (fig. 32). It is chiefly the character of the pigment, which is somewhat different from the *A. laterna* type (inter alia the pigment on the margin of the embryonic fin) in common with the southern occurrence, which causes us to refer them to *A. Grohmanni*.

Of the 3rd species of Arnoglossus we have only 10 specimens, all from the west of the British Isles and the English Channel. Nine of them were taken in September 1906, while the tenth the smallest is from September 1905. Its length is 15·5 mm. This and one other specimen of 18 mm. both have a much elongated dorsal fin ray, while the corresponding ray in the larger, yet quite symmetrical post-larvæ is scarcely longer than the succeeding. What on the whole unites these 10 specimens, besides the considerable size reached while still symmetrical, is amongst other things, as will be seen below, the characteristic pigmentation, the agreement in number of rays and vertebræ and in distribution.

Fig. 26 shows the smallest of the specimens belonging here we have in our possession. It was taken 2—IX—1905 in the Pentland Firth. The blind side of the same specimen is shown in fig. 29. As appears from this last figure the elongated ray in this A. species is also the second ray in the dorsal fin. The larva otherwise resembles in form an *A. laterna* of the same length. The development of the rays etc., is well advanced, the ventrals are formed, the pectoral still larval. There are 99 D., 77 A., Vert. 10 + 33, thus higher numbers than those in *A. laterna* (see later). The pigmentation reminds one slightly

of that in *A. laterna* larvæ. In the same region where in *A. laterna* and *Grohmanni* we find or may find a dorsal and just under it a ventral pigment spot, we also find a couple of spots in the present larvæ (fig. 26). There is only this difference that the spots here are situated out beyond the interspinous bones on the fin rays themselves, respectively on D and A. This position for the two large pigment spots is so conspicuous that it immediately separates these 10 specimens from all the rest. Further, we also find a fairly dense row of chromatophores at the proximal ends of the interspinous bones of D and A, just as is also found in the *A. Grohmanni* and *laterna* larvæ, only that the spots and accumulations of chromatophores do not appear here as in the two above-named species.

One of the largest larvæ belonging here is shown in fig. 27; it was taken in the Bay of Biscay over 400 meters on 11—IX—1906. It still has an almost perfectly symmetrical form. The length is 35·5 mm. The transformation of the eye has just begun, the right eye is placed about $^1/_2$ mm. higher than the left. The ventral rays have grown in size, the front part of the dorsal fin has reached its final position, but the pectorals still have their larval character. The height of the body has increased, the greatest height, not counting the dorsal and anal fins, now lying behind the anus, whereas before it was in front of this. We find D: 101, A: 78, C: 17, Vert. 10 + 33. The pigment is distributed as in fig. 26, but in addition other spots begin to appear in the dorsal and anal fins in front of the two conspicuous spots mentioned above.

In our specimens of this size there is no specially elongated dorsal fin ray, but the appearance, number of rays and the position of the large pigment spots on the fins themselves etc. nevertheless connect quite closely the separate stages shown in figs. 26 and 27.

Fig. 28 shows the most developed specimen in our possession. It was taken in the western end of the Channel on 19—IX—1906. The total length is 29·5 mm. The transformation of the eye is now almost completed and takes place in exactly the same way in this species as in *A. laterna* (see EHRENBAUM, 6a). Permanent rays have begun to form in the pectorals. In the other fins we have D: 104, A: 81, C: 17, No. of vertebræ: 9 + 33.

In both D and A pigment spots now appear at slight distances from one another; the same begin to appear along the lateral line and scattered over the eyed side of the head.

Both in the pigmentation and in the high number of rays and vertebræ these larvæ figured, as on the whole all the 10 specimens, show both mutual relationship and specific differences from *A. Grohmanni* and *laterna*. The geographical distribution is also characteristic for them; we give here a short list of the places at which they were found.

9—IX—06	St. 188:	48° 12′ N.	8° 52′ W.	490 Meters	With exception of the occurrence in the Pentland Firth they all lie just off the Channel or in the western part of this.
10—IX—06	- 189:	47° 22′ N.	7° 55′ W.	> 3500 —	
11—IX—06	- 190:	46° 30′ N.	7° 00′ W.	4000 —	
12—IX—06	- 193:	47° 13′ N.	6° 01′ W.	950-210 —	
13—IX—06	- 195:	48° 28′ N.	5° 42′ W.	170 —	
14—IX—06	- 196:	49° 24′ N.	3° 25′ W.	76 —	
15—IX—06	- 197:	49° 43′ N.	2° 43′ W.	56 —	
2—IX—05	- 169:	Pentland Firth		70 —	

They must therefore be referred to a third Arnoglossus species, and it seems obvious that they must be considered as belonging to *A. lophotes*, with which there is good agreement in regard to the high number of rays and vertebræ as well as in the distribution. We give here a summary of the number of rays and vertebræ in the three species now under discussion.

	D.	A.	Vertebræ Abd. + Caud. = Total
1. *Arnoglossus lophotes*			
Holt & Calderwood; 12 specimens	95—102 (1 with 93)	74—81 (1 with 69)	9 + 30 / 9 + 33 } 39—42
— our 10 specimens	95—105	74—78	10 spec.: 41—43 (8 had 42—43)
2. *Arnoglossus Grohmanni*			
Moreau (Pois. de la France)	84—90	55—67	.....
— 7 of our specimens	87—94	65—73	40—41
3. *Arnoglossus laterna*			
Holt & Calderwood, Ehrenbaum; 11 specimens	84—94	64—72	10 + 28 / 10 + 29 } 38—39
A. C. Johansen; Kattegat specimens	.....	.....	3 had 38 7 - 39 15 - 40

As I do not have any large material of adult specimens of *A. lophotes,* I am unable to raise again the discussion regarding the independence of this species; this has been done recently by Holt and Calderwood and also Collett (13 & 3) see also Günther (10) and Cunningham (4e)). If our identification of the last-named larvæ is correct, we must with Collett maintain *A. lophotes* as a quite independent species, but perhaps we have here quite an unknown species; new investigations must determine this.

There is no special reason to go deeper into the literature of the postlarvæ of the Arnoglossus genus, as this has already been done so thoroughly by Ehrenbaum as late as 1905 (6a and b). On the other hand, I think there is some reason to discuss some of the biological conditions concerning these species.

Undoubted larvæ of *A. Grohmanni,* metamorphosed but still living pelagically, with the 2nd dorsal fin-ray elongated, were found near the Spanish coast right in the Bay of Biscay at St. 40, 41, 42 and 45 (at depths of 102, 348, 420 and 125 meters) in the beginning of May 1906. At St. 40 the four small, strongly pigmented larvæ mentioned above were also taken (see fig. 33); at St. 194, Brittany on 12th Sept. 1906, further, the above-named, quite small, strongly pigmented larvæ with very long "tentacle" (see fig. 32). If these can rightly be referred to *A. Grohmanni* and its spawning season does not extend over a very great part of the year, but as stated (cf. Holt, 11b and c) falls in the summer, its pelagic life as larva must cover the whole winter. Otherwise we should not be able to find the fry as large pelagic larvæ in process of metamorphosis in May together with quite small larvæ. Its considerable size would also indicate that its development is slow.

A similarly long postlarval life may also be ascribed to the still larger larvæ of *A. lophotes*; I have however no quite small larvæ of this species and no large ones from the spring months, so that for this species I can only speak by analogy.

In this prologed larval stage I find one of the reasons why *A. Grohmanni* does not exist in the North Sea. Thus, J. Boeke (1, p. 31—32) seems only to have found larvæ of *A. laterna* near the coast of Holland and makes no mention at all of the discovery of *A. Grohmanni.* This last species is not known either at Heligoland (Ehrenbaum, 6a) nor from the northern part of the North Sea or Scandinavia. On the other hand, it is found from the Channel southwards right into the Mediterranean (see inter alia 9) and can with certainty be regarded as a southerly form with its northern boundary on the west side of the British Isles.

A long larval life which extends over the summer and entire winter is certainly difficult to connect with the very variable temperature of the North Sea.

The pelagic post-larval stages of Solea variegata.

In the collections of the "Thor" we have a number of *Solea* larvæ, partly from the North Sea and partly from the Channel and the waters west and south of the British Isles. The larvæ of *Solea lutea* are most strongly represented and some larvæ of *S. vulgaris* also occur. In addition to these two, a group of pelagic *Solea* larvæ is present, of quite a different appearance from the others but all undoubtedly connected with each other.

While the development of *S. vulgaris* and *lutea* is well known through such papers as Fabre-Domergue and Bietrix: "Développement de la Sole" (Paris 1905) and Ehrenbaum's papers (6a and b), nothing is actually known beyond the very earliest stages of the other *Solea* species which live within the region investigated by the "Thor". Cunningham (4a and b) and Holt (inter alia 11a) have hatched out the eggs of *Solea variegata* and *lascaris* and described the appearance of the tiny larvæ, but that is, so far as I am aware, all that is known up to the present about the postlarvæ of these forms.

Our undescribed *Solea* larvæ form a series, of which the youngest is a perfectly symmetrical specimen, 6—9 mm. long., here as always measured on formaline specimens, and the oldest is 18·3 mm. long and, notwithstanding the transformation of the eye, still not out of the larval stage, as is evident amongst other things, from the fact that permanent rays are not yet present in the pectoral fins.

All the specimens agree in regard to pigmentation, in the absence of any apparent sign of a swim bladder, which is in contrast to the *S. vulgaris* and *lutea* larvæ, and lastly in sameness in the number of rays and vertebræ, so far as the stage of development has allowed this to be determined with certainty. Finally the geographical distribution is also characteristic compared with the fry of the known species. The most of them have been taken in the months of May—July south-west of Ireland over great depths (1000—4000 met.), only a few being taken in the western part of the channel, and at one single station north of the Hebrides.

Fig. 35 represents a 7 mm. long, perfectly symmetrical larva taken at Stat. 32, 48° 40′ N., 5° 04′ W. at a depth of 113 met., young-fish trawl, 120 met. wire out, 7—V—1906. The distance from the tip of the snout to the anus is 3 mm.; the notochord is slightly bent upwards; of indications of rays only the hypural are visible. (According to Cunningham (4a and b), the embryonic caudal rays in the newly hatched *Solea variegata* are very early developed). There are slight signs of dorsal and anal interspinal bones, the pectoral fins have already a large pigmented margin and reach almost to the anus; while as yet no trace of ventral fins is to be seen. The mid-brain is strongly arched.

The pigmentation is characteristic; small chromatophores are spread over almost the whole body, sparingly on the sides of the body and tail and on the posterior part of the embryonic fin. Along the proximal ends of the dorsal and anal interspinous bones there is a single row of small pigment cells. This arrangement is also found in the other known larvæ of *Solea*; only here the number of chromatophores in each row is much smaller and the single cells much larger (stellate). Along the dorsal side of the notochord in the foremost $^{2}/_{3}^{rds}$ of its length a similar row of pigment cells is also found. In contrast to the *S. lutea* and *vulgaris* larvæ, as mentioned, any apparent sign of a swim-bladder is lacking both in this and in the later developmental stages of this Solea species.

Fig. 36 shows an older link in the series, taken at Stat. 30, 50° 11′ N., 4° 18′ W. at a depth of 51 met., young-fish trawl 50 met. wire out, 7—V—1906. The total length is 10 mm.; the anus is placed 4 mm. behind the tip of the snout. The left eye is drawn forwards and up towards the edge of the dorsal ridge, but cannot yet be seen from the right side.

The formation of the rays in the unpaired fins is well advanced; we find ca. 68 D, ca. 55 A, 16 C, but it must be added, that the full number are not yet formed, especially those posteriorly; Vert. 9 + 31.

The forward movement of the dorsal fin towards the head has begun; the foremost interspinous bone is inclined forward parallel to the dorsal outline of the mid-brain and to it are attached the 3 succeeding interspinous bones (cf. FABRE-DOMERGUE and BIÉTRIX (7) p. 144). The pectoral fins are still larval with strongly pigmented edges. The beginnings of the ventral fins are just indicated.

The pigment consists as before essentially of small stellate chromatophores distributed sparingly on the posterior part of the body.

Similarly the dorsal and ventral longitudinal rows of chromatophores at the proximal ends of the interspinous bones are again found there. The number of pigment cells has now increased (to ca. 70 dorsal, ca. 50 ventral). The dorsal row follows the interspinous bone of the dorsal fin right on to the head. A 3rd and 4th longitudinal row are indicated at the distal ends of the interspinous bones of D and A, a 5th along the dorsal margin of the notochord. All the longitudinal stripes, especially the last, only slightly dominate and do not determine the impression of the general appearance; what is characteristic in the distribution of the pigment in this species — in contrast to that in the *S. lutea* and *vulgaris* larvæ — is just its distinctly scattered nature.

The oldest specimen we have is shown in fig. 37; it was taken at Stat. 61, 51° 04′ N., 11° 39′ W., depth ca. 1320 met., young-fish trawl 500 met. wire out, 31—V—1906. The length is 18·3 mm., of which only 5 mm. belongs to the part anterior to the anus. The migrating eye now lies over on the right side and the dorsal fin has reached the tip of the snout. The transformation of the eye takes place as in *S. lutea* and *vulgaris*, in front of the anterior part of the dorsal fin, not through the tissues of the head (cf. inter alia 6a).

The transformation is still not quite completed, amongst other things the pectoral fins are still larval. It thus seems that this species only completes its pelagic life at sizes which exceed the corresponding lengths in the known species of *Solea* (*S. vulgaris* finishes its pelagic life at ca. 11 mm. its metamorphosis at ca. 15 mm. (6b and c), *S. lutea* at a still smaller size (6b and c)).

The number of rays and vertebræ amount to ca. 76 D., ca. 58 A., ca. 18 C., Vert. 9 + 32. The pigment has disappeared from the body itself and is only preserved on the unpaired fins, as also in the dorsal and ventral longitudinal rows.

The teeth are now rapidly developing on the blind side of the jaw.

With regard to the question of referring these *Solea* post-larvæ to one of the known *Solea* species, a selection must probably be made amongst the following 3: *S. lascaris* Bonap., *variegata* Don. and *greenii* Günth.

All these have their northern boundary on the S. W. and W. coasts of the British Isles, not one of them is known to enter the eastern part of the Channel, and only one, viz: *S. variegata* goes into the North Sea. This distribution coincides with the occurrence of the post-larvæ here spoken of. It is also consistent with the fact that at least the 2 last-named species can occur at great depths. As none of our fry are completely metamorphosed (passed over to the bottom stage), the question of species cannot be decided simply by the external form; it can only be said that the lowest nostril on the blind side is tubular in the largest of the figured larvæ (cf. CUNNINGHAM's figure of *S. variegata* (4b)). On the other hand, the number of fin rays and vertebræ give good indications towards a satisfactory solution.

Bringing together the number of fin rays from the different authors who have described these species, we obtain the following summary (see amongst others 4b, 5 and 12b).

	D.	A.	Vertebræ
Solea lascaris Bonap.	79—89	67—77	46
Solea variegata Don.	63—74—77	52—58—61	10 + 30 (31)
Solea greenii Günth	80—90	ca. 65—75	.....
Our postlarvæ (6 spec.)	71—76	ca. 46—60	9 (10) + 30 (31) (32)

Even if the numbers must be accepted with reservation, it is quite clear that the post-larvæ only agree well in regard to these with *Solea variegata* and only with this.

This species is not so seldom met with in the western part of the Channel and on the S. W. coast of Ireland, where it is taken at depths from between 10—20 and although rarely — at least down to 160 fathoms (12b). It is also known on the west coast of Scotland and from the Moray Firth (T. W. FULTON in 22nd Rep. Fish. Board of Scotland, p. 286, 1904) but otherwise not from any part of the North Sea. Towards the south it goes through the Bay of Biscay into the Mediterranean. Its spawning season in the Channel is known to begin in the early spring, and to continue right through spring and summer. The occurrence of our post-larvæ in the month of May—June to September agrees also with these statements, a fact however that cannot be reckoned upon as being specially characteristic for this species.

CUNNINGHAM has described and figured eggs and newly hatched larvæ (partly in 4a p. 23 — and partly in 4b, p. 90); the largest was only 2·52 mm. long and still had a large yolk-sac. The pigment consisted partly of yellow chromatophores distributed over the body, embryonic fins and the surface of the yolk-sac and partly of black pigment, less abundant but also diffusely spread over the body and the yolk-sac, as also in a single row within the dorsal and ventral edge of the fin margin. The embryonic rays in the caudal fin are already perceptible. On the whole there is, in spite of difference in age, a certain pigmentary resemblance in these and our smaller larvæ. It may be mentioned here that MARION (15, Pl. 1, fig. 10) figures a *Solea* larvæ with large yolk-sac and 3 mm. long, which probably belongs here, but adds nothing new.

The smallest *Solea variegata* positively certain as such are two transformed young specimens of 4·5 and 4·6 cm. mentioned by CUNNINGHAM (J. M. B. A., p. 104, Vol. 2) as taken 2 miles N. of the Eddystone in deep water and also one which HOLT mentions as taken from the stomach of a *Trigla lyra*, 25 mm. long, trawled at 62—52 fathoms (11a p. 94), unfortunately without the least description. He remarks that the young (the metamorphosing larvæ) are known by well-marked bars of pigment. This is not borne out by any of our larvæ, but as mentioned before, the metamorphosis is still far from being complete.

From the little we thus know about the occurrence of the young specimens it would seem as if they must be sought for over or in greater depths than for example the postlarval stages of *Solea lutea* and *vulgaris*; our pelagic young have a similar occurrence.

To sum up, the number of rays and vertebræ, partly also the appearance, the distribution and time of year for their occurrence, seem to refer the postlarvæ described here to *Solea variegata*; we still lack however both the first and the last stages in the series before the course of development can be said to be fully known.

LIST OF LITERATURE

1 Boeke, J.: Eier- und Jugendformen von Fischen d. südlichen Nordsee etc. 36 pp. with 2 Pl. (Verhandl. uit Het Rijksinst. voer het Onderzoek d. Zee. 1ste Deel, IV, 1906.)

2. Cligny, A.: Poissons des cotes d'Espagne et de Portugal. (2 Partie.) (Annal. de la station aquicole de Boulougne-sur-mer. Nouv. sér. Vol. I. 1905.)

3. Collett, R.: Poissons provenant des compagnes du yacht l'Hirondelle 1885—88. (Résultats des campagnes scientif. accompl. sur son Yacht par Albert I. Fascicule X. Monaco 1896. 198 p.; 6 pl.)

4. Cunningham, J. T.:
   a) Studies of the Reproduction and Developm. of Teleost Fish. occur. in the neighbourh. of Plymouth. (Journ. British Mar. Biol. Ass. Vol. I. 1889—90. p. 10—54. pl. I—VI.)
   b) A treatise on the common sole. Plymouth 1890.
   c) The rate of growth of some sea fishes etc. (J. Brit. M. Biol. Ass. V. II. 1891—92. p. 95—118.)
   d) Ichthyological contributions. (Ibid. p. 325—332.)
   e) On second. Sexual Charact. in t. genus Arnoglossus (Proc. Zool. Soc. London. 1890) p. 540—546.

5. Day, Fr.: The fishes of Great Britain. Vol. I—II. 1880—84.

6. Ehrenbaum, E.:
   a) Eier u. Larven d. Deutschen Bucht. I. (Wissenschaft. Meeresuntersuch. Abt. Helgoland 1897 S. 253—324. Taf. III—VI.
   b) Eier u. Larven von Fischen, I, in «Nordisches Plankton», 216 p., 4te Lief. 1905.
   c) Über Eier u. Jugendformen d. Seezunge u. a. im Frühjahr etc. (Wissens. Meeresunters. etc. N. F. Bd. VIII. Abt. Helgoland. H. 2. 1908. p. 201—270.)

7. Fabre-Domergue et E. Biétrix: Développement de la Sole (Solea vulgaris). 266 p., 8 pl. (Travail du laboratoire de zoolog. maritime de Concarneau.) Paris 1905.

8 Fulton, T. W.: Ichthyological notes. (22nd Ann. Rep. Fish. Board f. Scotland 1904, pt. III, p. 281—287, pl. XVIII.)

9. Graeffe, Ed.: Uebersicht d. Seethierfauna des Golfes von Triest nebst notizen über Vorkommen Lebensweisen, etc. d. einz. Arten. (Arb. Zool. Inst. Univ. Wien u. Zool. Stat. Triest v. 7. Wien 1886).

10. Günther: A Contribution to our Knowledge of British Pleuronectidæ. (Proc. Zool. Soc. London 1890. p. 40—44. Pl. III.)

11. Holt, E. W. L.:
   a) On the eggs and larvae and postlarval stages of teleosteans. (Scientif. Trans. R. Dublin, Soc. ser. II. Vol. V. 1893. p. 1—121, pl. I—XV.)
   b) Prelim. note on the reprod. of teleost. fishes in the South-West. district. (Journ. Brit. Mar. Biol. Ass. Vol. V. 1897—99. p. 41—50.)
   c) The reproduct. of teleost. fishes etc. (Ibd. p. 107—155.)
   d) Recherches sur la reproduction des poissons osseux, principalement dans le Golfe de Marseille. (Annal. du Musée d'Histoire Natur. de Marseille. Zoologie. Tome V. Nr. 2. 1899. p. 1—128. pl. 1—9.)

12. Holt, E. W. L. and Byrne, L. W.:
   a) On a young stage of the white sole, Pleuronectes (Glyptocephalus) cynoglossus. (Rep. on the Sea- a. Inland Fisheries of Ireland p. 1901. Dublin. (App. IV to Pt. II. 3 p., pl. III.)
   b) Figures and descriptions of the British and Irish species of Solea. (Ibid. p. 1902—03, p. 164—175, pl. XXIX—XXXIV. Dublin 1905.)

13. Holt, E. W. L. and Calderwood, W. L.: Survey of Fishing grounds, West Coast of Ireland 1890—91: Report on the rarer fishes. (The Scientif. Transact. Royal Dublin Society (ser II) vol. V. 1895, p. 361—512, pl. XXXIX—XLIV.)

14. Holt, E. W. L. and Scott, S. D.: A Rec. of teleost. eggs and larvæ obs. at Plymouth in 1897. (Journ. Br. Mar. Biol. Ass. V. 97—99, p. 156—171.)

15. Marion, A. F.: Oeufs flottants et alevins observés dans le Golfe de Marseille dur. l'année 1890. (Annal. du Musée d'Histoire Nat. de Marseille. Zoologie T. IV. 1890—94. 4°. p. 112—121. pl. 1 & 2.)

16. Petersen, C. G. Joh.:
   a) On the young stages of the genus Zeugopterus. (Report Dan. Biolog. Stat. XII, 1902—03, p. 25—32, pl. 1. Kbhvn. 05.)
   b) On the larvae and postlarval stages of some Pleuronectidæ (Pleuronectes, Zeugopterus). With a «Preliminary note» [Medd. fra Komm. f. Havunders. Serie Fiskeri Bd. II. Nr. 1, 1906, p. 1—9, pl. 1.

17. Raffaele, F.: Le uova gallegianti e le larvæ dei teleostei nel golfo di napoli. (Mitth. a. d. Zoolog. Station zu Neapel. VIII. 1888. p. 1—84. Taf. I—V.)

EXPLANATION OF THE FIGURES

Plate I.

Fig. 1. *Zeugopterus punctatus:* 5·8 mm.; "Thor" St. 177, 56°21 N., 12°15′ E.; depth 25 M.; young-fish trawl 65 M. wire out; 8—IX—1905. Like all the others, drawn from a specimen preserved in 2 % formaline. The eyes are placed symmetrically and the notochord is quite straight. With exception of a few hypural there are no traces of permanent rays in the embryonic fin, nor in the larval pectorals. The developing ventral fins are but faintly indicated. The spinal cord is already covered by densely placed chromatophores over its whole course. On each side of the head in the oral region we see a pair of "otocystic spines"; no other spiny equipment yet present.

Fig. 2. *Z. punctatus:* 8 mm.; "Thor" St. 30, 50°11′ N., 4°18′ W.; depth 51 M.; young-fish trawl 50 M. wire out; 7—V—1906. Symmetrical larva with urochord slightly bent upwards. Faint, but distinct traces of the hypural rays; almost all the interspinous bones of the dorsal and anal fins are laid down. In addition to the slender "otocystic spines", almost equal in length to the diameter of the eye, 1 spine is present on each side of the mid-brain.

Fig. 3. *Z. punctatus:* 8·9 mm. The figure is a combination from two specimens; one from the "Thor" St. 96, 58°43′ N., 4°55′ W.; depth 70 M.; young-fish trawl 110 M. wire out; 28—VI—1906; the other from the "Thor" St. 66, 58°07′ N, 6°10′ W.; depth 60 M., young-fish trawl 65 M. wire out; 31—V—1905. Weak asymmetry. Interspinous bones are now laid down in the whole of the dorsal and anal fins, as also the proximal portions of the permanent rays in almost the whole length of these fins.

In addition to the "otocystic spines", spines are present on the lateral aspects of the mid-brain, 2 on the left side, 3 on the right. The spines on each side give the impression of being mutually connected by a thin skin. A single small spine is present on the posterior border of the preoperculum.

Fig. 3a shows the same specimen seen from above. The spines mentioned on the mid-brain are seen distinctly behind and over the eyes; cf. also Holt's fig. 97 (11a), which only shows one such spine on each side.

Fig. 4. *Z. punctatus:* 9 mm.; "Thor" St. 84, 52°54′ N., 9°36′ W.; depth 60—70 M.; young-fish trawl 120 M. wire out; 21—VI—1906. The asymmetry is distinct. 94 rays are laid down in the dorsal fin, < 68 in the anal, ca. 15 in the caudal, vertebræ $10 + > 24$ Single rays can be detected in the ventral fins. In this specimen only one of the spines on the mid-brain is preserved on the left side, those on the right side have disappeared (broken off?).

Fig. 5. *Z. punctatus:* 11 mm.; "Thor" St. 95, 58°10′ N., 6°12′ W.; depth 120 M.; young-fish trawl 60 M. wire out: 27/28—VI—1906 The eye is now in process of transformation. There were of rays, in D. ca. 92, in A. 72, in C. 16, vert. $10 + 26$. The spiny equipment almost as in the previous, but also some small spines at the upper end of the pectoral arch.

Fig. 6. *Z. punctatus:* ca. 12·5 mm.; "Thor" St. 115, 58°25′ N., 1°37′ W.; depth 103 M.; 25 M. wire out; 15—VII—1905. The migrating eye right on the dorsal ridge. Number of fin rays and vertebræ: D. ca. 91, A. ca. 70, C. 16, V. 6/6, Vert. $10 + 26$. Pectorals still larval.

The spiny equipment is more developed than in the previous; it consists, in addition to the "otocystic spines", of a few preopercular spines, 4 small mid-brain spines on the left side, 3 on the right, as also of a group of small spines posteriorly on the region between the eyes, lastly of quite a few "scapular" spines. Developing teeth are now distinct, especially on the blind side of the lower jaw.

Fig. 7. *Zeugopterus megastoma:* 11·7 mm.; "Thor" St. 27; 61°31′ N., 0°39′ W.; depth 180 M.; young-fish trawl 65 M. wire out; 12—V—1905. Symmetrical; the notochord extremely slightly bent. The embryonic fin cannot be followed further than to above the highest part of the mid-brain; its apparent absence in the figure is due to faulty preservation. Developing interspinous bones are present in the front 2/3rds of the later dorsal and anal fins; further, distinct hypural rays are laid down. Large larval pectorals. Of spiny equipment only 2 "otocystic spines" were observed on each side.

Fig. 8. *Z megastoma:* 12·7 mm.; "Thor" St. 64, 59°17′ N., 7°29′ W.; depth 89 M.; young-fish trawl 65 M. wire out; 30—V—1905. Faintly asymmetrical; the urostyle now distinctly bent upwards. The proximal parts of the dorsal and anal fins are almost all laid down; the number can be given as: D. > 80, A. > 52, Vert. $10 + > 30$.

Fig. 9. *Z. megastoma:* 15·2 mm.; "Thor" St. 70, 57°45′ N., 9°57′ W.; depth 1150 m.; young-fish trawl 65 M. wire out; 7—VI—1905. Asymmetry distinct. Developing fin-rays in the ventrals distinct. D. ca. 84, A. ca. 70, C. $1 + 15 + 1$; the rays in D. and A. now almost reach out to the margin of the embryonic fin; Vert. $10 + 32$. The teeth are seen to be developing, especially on the lower jaw of the blind side.

Fig. 10. *Z. megastoma:* 19 mm.; "Thor" St. 70, 57°45′ N., 9°57′ W.; depth 1150 M.; young-fish trawl 25 M. wire out; 7—VI—1905. The migrating eye is situated on the dorsal ridge. There are ca. 85 D., ca. 69 A., 18 C. and 6/6 ventral rays; Vert. $10 + 32$. Teeth most numerous on the jaws of the blind side (ca. 10/10).

Fig. 11. *Z. megastoma:* ca. 32 mm.; "Thor' St. 71, 57°47′ N., 11°33′ W.; depth 1985 M.; young-fish trawl 300 M. wire out; 7—VI—1905. The dorsal fin has reached its permanent position above the migrating eye. D. ca. 88, A. ca. 69, C. 17, V. 6/6; pectorals still larval; Vert. $10 + 32$; ca. 18—20 teeth are present above and below both on the blind and eyed side.

Fig. 12. *Z. megastoma:* ca. 30 mm.; "Thor" St. 80, 51°34′ N., 11°50′ W., depth 960—1140 M.; young-fish trawl 200 M. wire out; 16—VI—1906. The metamorphosis is almost completed; permanent rays begin to appear in the pectoral fins, ca. 10 could be counted. D. ca. 89, A. ca. 69, c. 19, V. 6/6; Vert. $10 + 31$; ca. 25 teeth above and below both on the blind and eyed side. As in the previous specimen, only the 2 "otocystic spines" are to be seen on each side.

Fig. 13. *Zeugopterus norvegicus:* 6 mm.; "Thor" St. 65, 58°45′ N., 6°26′ W.; depth 100 M.; 65 M. wire out; 31—V—1905. Quite symmetrical; the urochord straight. In the high embryonic fin, which is very diffusely pigmented, traces of the caudal

rays can be seen. Proximal traces are also to be seen of the anterior interspinous bones in the later dorsal and anal fins. Large larval pectorals. There are 8 slender spines along the posterior border of the preoperculum, a few spines on the outer side of the lower jaw, which seems to be a little more strongly developed on the right side; lastly there is a group of small spines (5—6) at the uppermost end of the pectoral arch.

Fig. 14. *Z. norvegicus:* 8 mm.; "Thor" St. 65, 58°45′ N., 6°26′ W.; depth 100 M.; young-fish trawl 65 M. wire out; 31—V—1905. Symmetrical; urostyle but very little bent upwards. Distinct traces of rays in the hypural part of the caudal fin. Interspinous bones laid down for almost the whole of the dorsal and anal fins, as also the basal parts of the corresponding rays. The ventrals have begun to appear. About 10 preopercular spines and 6 spines along the lower jaw on each side; the pectoral spines as before.

Fig. 15. *Z. norvegicus:* 9·0 mm.; "Thor" St. 65, 58°45′ N., 6°26′ W.; depth 100 M.; young-fish trawl 65 M. wire out; 31—V—1905. Asymmetry begins to appear; urostyle now distinctly bent upwards. The developing rays in D., A. and C. are now more advanced; they number respectively: ca. 77, ca. 62, ca. 12. The ventral fins likewise show rays beginning to form. The spines on the lower jaw and on the preoperculum as in the previous larva; in contrast to this, we here find 2 rows of slender, small spines at the uppermost end of the pectoral arch (ca. 10 in the anterior row, ca. 6 in the posterior). The spiny equipment of the right side seems less developed, which may perhaps be due to faulty preservation or other cause.

Fig. 16. *Z. norvegicus:* 11 mm.; "Thor" St. 129, 62°40′ N., 8°43′ W.; depth 512 M.; young-fish trawl 200 M. wire out; 25—VIII—1905. The migrating eye is now placed right on the dorsal ridge. Rays in the unpaired fins, all of which are now formed, D. 78, A. 68, C. 16 and V. 6/6; Vert. 10 + 24 The spiny equipment essentially as in the specimen represented in fig. 15. A few teeth are on the blind side of the jaw anteriorly.

Fig. 17. *Z. norvegicus:* 10.4 mm.; "Thor" St. 69; 57°46′ N., 9°01′ W.; depth 144 M.; young-fish trawl 65 M. wire out; 6—VI—1905. The migrating eye has now moved to the left side of the head; the front part of the dorsal fin is seen advancing over this eye. There are ca. 77 D., ca. 68 A., 16 C., 6/6 Ventr. Vert. 10 + 26, these final numbers being determinable with certainty. The spiny equipment is now reduced; faint remains of the preopercular spines as also of the clavicular may be noticed, otherwise none. This applies to the spines both on the left and right side. On the jaws of the blind side there are now ca. 10 & ca. 14 teeth; none have yet appeared on the eyed side.

Fig. 18. *Z. norvegicus:* 12 mm.; "Thor" St. 129, 58°05′ N., 8°24′ E.; depth 230—250 M.; young-fish trawl 260 wire out; 25—VII—1906. The dorsal fin has now reached its permanent position; the pigmentation as also the pectoral fins are however still larval. In the other fins there are 80 D., ca. 66 A., 16 C., 6/6 V.; Vert. 10 + 27. The spiny equipment as before, but seems to be even more reduced on the right (blind) side than on the eyed side. A few teeth begin to show anteriorly on the dental of the eyed side.

Fig. 19. *Z. norvegicus:* 15 mm.; "Thor" St. 169, 58°43′ N., 3°30′ W.; depth 75 M.; young-fish trawl 65 M. wire out; 2—IX—1905. The specimen figured has completed its metamorphosis. The pigmentation differs from that of the pelagic larvæ, and the fins, which have longest kept their larval character, namely the pectorals, have developed permanent rays. There are ca. 80 D., ca. 68 A., 7/7 V., 16 C., ca. 11 P.; Vert. 10 + 27. Faint remains only of the preopercular spines. Scales beginning to form. Teeth well-developed on both sides of the lower jaw.

Plate II.

Fig. 20. *Zeugopterus unimaculatus:* 6·7 mm.; "Thor" St. 99, 50°43′ N., 0°43′ E.; depth 41 M.; young-fish trawl 65 M. wire out; 30—VI—1905.

Fig. 21. *Z. unimaculatus:* 8 mm.; taken with the foregoing.

Fig. 22. *Zeugopterus Boscii:* 7 mm.; "Thor" St. 77; 50°45′ N., 11°53′ W.; depth > 2000 M.; young-fish trawl 200 M. wire out; 13—VI—1906.

Fig. 23. *Z. Boscii:* 97 mm.; "Thor" St. 71; 48°05′ N., 11°50 W.; depth > 4000 m.; young-fish trawl 300 m. wire out; 8—VI—1907.

Fig. 24. *Z. Boscii:* 10·4 mm.; "Thor" St. 52, 48°43′ N., 12°05′ W.; depth 1860 M.; young-fish trawl 200 M. wire out; 21—V—1906.

Fig. 25. *Z. Boscii:* 17 mm.; "Thor" St. 64; 49°17′ N., 14°03′ W.; depth > 4000 M.; young-fish trawl 200 M. wire out; 1906.

Fig. 26. *Arnoglossus lophotes:* 15·5 mm.; "Thor" St. 169; 58°43′ N., 3°30′ W.; depth 75 M.; young-fish trawl 65 M. wire out; 2—IX—1905.

Fig. 27. *A. lophotes:* 35·5 mm.; "Thor" St. 190, 46°30′, 7°00′ W.; depth > 4000 M.; young-fish trawl 300 M. wire out; 11—IX—1906.

Fig. 28. *A. lophotes:* 29·5 mm.; "Thor" St. 195, 48°28′ N., 5°42′ W.; depth 170 M.; young-fish trawl 65 M. wire out; 13—IX—1906.

Fig. 29. *A lophotes:* Anterior part of specimen shown in fig. 26, seen from the right side.

Fig. 30. *Arnoglossus laterna:* The figure is combined from 2 specimens; 18·2 & 18·9 mm.; taken by the "Thor" in the North Sea; the one W. of Horns Reef, the other W. of Vyl lightship, depth 50 and 24 M. respectively; young-fish trawl on bottom. IX—1904.

Fig. 31. *A. laterna:* The anterior region of larva shown in fig. 30.

Fig. 32. *Arnoglossus Grohmanni?* ca. 5 mm.; "Thor" St. 194, 47°42′ N., 5°30′ W.; depth 130 M.; young-fish trawl 65 M. wire out; 12—IX—1906.

Fig. 33. *A. Grohmanni?* ca. 8 mm.; "Thor" St. 40, 43°23′ N., 2°02′ W.; depth 110 M. young-fish trawl 100 M. wire out; 11—V—1906.

Fig. 34. *A. Grohmanni:* Anterior region of a specimen seen from the blind side; 28·5 mm.; "Thor" St. 41, 43°23′ N., 2°01′ W.; depth 102 M.; young-fish trawl 15 M. wire out; 15—V—1906.

Fig. 35. *Solea variegata:* 7 mm.; "Thor" St. 32, 48°40′ N., 5°04′ W.; depth 113 M.; young-fish trawl 120 M. wire out; 7—V—1906.

Fig. 36. *S. variegata:* 10 mm.; "Thor" St. 30, 50°11′ N., 4°18′ W.; depth 51 M.; young-fish trawl 50 M. wire out; 7—V—1906.

Fig. 37. *S. variegata:* 18·3 mm.; "Thor" St. 61, 51°04′ N., 11°39′ W.; depth 1320—1120 M.; young-fish trawl 500 M. wire out; 31—V—1906.

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